Searching for Improved Treatment Options for Human Internal Decontamination A Nanoscale Approach

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Overall Research Goal

Develop, design, and demonstrate a novel, integrated system based on magnetic nanoparticles for selective, rapid removal of biological, chemical, and radioactive biohazards from humans.

Current Detoxification Methods and Limitations

Hemodialysis and Hemofiltration: Long procedure duration, extracorporeal circulation of large blood volumes, large-bore arterial access, non-selective substance removal, limited to hydrophilic substances with lower molecular weight

Plasmapheresis: Generally restricted to autoimmune diseases

Extracorporeal Immunoabsorption: Specific removal method but less effective, restricted to specific antibody-antigen interactions, requires circulation of large blood volumes

Direct Injection of Chelators and Antibodies ("Immunotherapy"): Incomplete antigen binding, relatively high antibody dosing; bound toxin can still be toxic or dissociate, leading to rebound intoxication

Overview of Proposed System

Injection

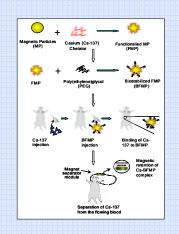
Magnetic nanospheres are developed that are biostabilized with polyethelyne glycol (PEG) to avoid rapid bioclearance. They are biodegradable and non-toxic and present a variety of specific toxin-binding receptors. These nanospheres are injected directly into the blood stream of exposed humans.

Chelation

Once injected, the nanospheres circulate freely through the blood stream, offering selective capture and sequestration of blood-borne toxins to the surface receptors.

Separation

The magnetic separator device allows blood to pass through a closed-loop system containing tubular micro-channels designed to optimize blood flow and particle removal. Small magnets within the device trap the particle-toxin complexes at the tube walls and the detoxified blood is returned into the body. After the procedure, the toxin-bound particles can be flushed from the removable tubing and used as an analyte in further testing.



Advantages

Therapeutically Superior: Active removal of biotoxins from exposed humans, not merely binding and passive secretion.

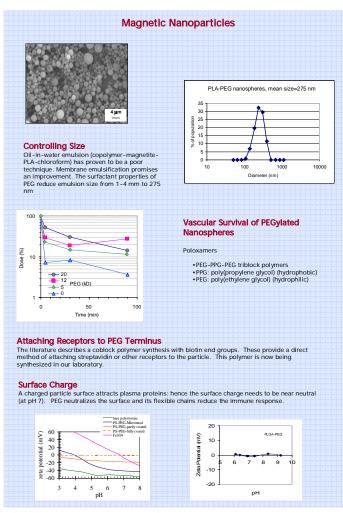
Blocompatible: Non-toxic, biodegradable nanoparticles not removed will pose no harm to the subject.

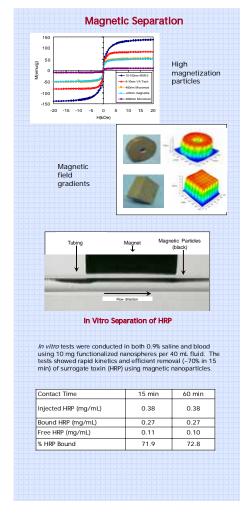
Diverse: Already existing and newly designed antitoxins, antibodies, and ligands can be attached and

multiple toxins can be removed ('cocktail' approach)

Repeatable: Chronic exposures or exposures with high tissue levels can be retreated.

Compact: Total MNP-antitoxin injected expected to be <2 mg/kg body weight; injectants and magnetic separator device engineered as hand-held, single-use, pre-sterilized, self-applicable unit (in-field use, etc.) Concentrate analyte for further identification.







Funding for this work provided by U.S. Department of Defense, Defense Advanced Research
Projects Agency: BioMagnetICs: and the Cancer Research Foundation and
Brain Research Foundation of The University of Chicago
Argonne National Laboratory is operated by the University of Chicago for the U.S. Department of Energy